

# PATENT SPECIFICATION

## 591,153



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### PROVISIONAL SPECIFICATION

#### Improvements in or relating to the Control of Epicyclic Variable Speed Gears

We, LAGONDA LIMITED, a company organised under the laws of Great Britain, of Staines, Middlesex, and WALTER OWEN BENTLEY, British subject, of Millbrook House, Colnbrook, Buckinghamshire, do hereby declare the nature of this invention to be as follows:—

This invention relates to the control of epicyclic trains of gears in a gearbox such as the Cotal gearbox in which the engaging of the gears is obtained electro-magnetically.

In gear boxes of this kind the reverse gear is obtained through an epicyclic form of gear train which is in effect entirely separate from the remainder of the gear box and is engaged not by electro-magnetic clutches but by mechanical means. The normal form of this reverse gear consists of a sun gear wheel comprising the driving member, a number of planet gears supported on a planet carrier and an internally toothed annulus gear comprising the driven member. The planet carrier member is formed with teeth on its outer periphery. In the neutral position these teeth are free and no drive is transmitted. For forward drive the planet carrier is moved endwise so that the teeth on its outer periphery engage with the corresponding internal teeth of the annulus and the gear rotates as a unit, the speeds of driving and driven members being equal. For reverse drive the planet carrier is moved endwise so that the teeth on its outer periphery engage with the corresponding internal teeth of the annulus and the gear rotates as a unit, the speeds of driving and driven members being equal. For reverse drive the planet carrier is moved endwise in the opposite direction until the teeth on its outer periphery engage with corresponding internal teeth on a fixed reaction member so that the annulus is driven in the opposite direction to the sun wheel and at a reduced speed as compared with the forward drive so that a reverse gear of approximately the same order of ratio as the first forward gear is obtained by the product of the reverse gear ratio itself and either the third or direct gear in the gear-

box proper. If the reverse gear were employed in conjunction with the first or second gear in the gearbox proper, this would put excessive torques on certain parts of the transmission.

One object of the present invention is to provide means whereby simultaneous engagement of the reverse gear with a low gear in the gear box is prevented.

A further object of the present invention is to provide means whereby alternate forward and reverse movements can be obtained by movement of a single lever only.

In one way of carrying out the invention where a single lever is employed the endwise movement of the planet carrier is effected by two solenoids. Movement of the lever to any of the positions for the forward gears first energises the solenoid which moves the planet carrier of the forward and reverse gear to the forward drive position. Movement of the lever to the reverse gear position first energises the other solenoid which moves the planet carrier of the forward and reverse gear to the reverse drive position and then energises the magnets for the third or fourth gear, whichever is required in conjunction with the reverse gear train to give the desired overall reverse gear ratio.

In an alternative arrangement in which two levers are employed, that which controls the forward and reverse gear engagement (which can, in this case, be either electrical, hydraulic or mechanical) also acts as a master switch and cut off the current supply to the normal gear control switch lever when the lever is moved to put into operation the reverse gear, and in the neutral position also. The reverse position of this forward and reverse control lever is also arranged to energise the magnets for controlling either top or third gear in the gearbox, whichever is required for obtaining the desired overall reverse ratio.

It will be seen that this forward and reverse control lever functions as a master switch which enables any of the gears to be put into operation when it is in its "for-

ward " position but, when moved to its " reverse " position, only the third or fourth gear is energised.

Dated this 5th day of March, 1945.

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COMPLETE SPECIFICATION  
Improvements in or relating to the Control of Epicyclic Variable Speed Gears

We, LAGONDA LIMITED, a company organised under the laws of Great Britain, of Staines, Middlesex, and WALTER OWEN BENTLEY, British subject, of Millbrook House, Colnbrook, Buckinghamshire, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to the control of epicyclic trains of gears in a gearbox such as the Cotal gearbox in which the engaging of the gears is obtained electro-magnetically.

In the normal or common type of Cotal gear box, two controls are used, a hand lever giving mechanical control over forward and reverse gears and an independent switch for selecting forward gears. Reverse gear is thus controlled by the hand lever, being obtained through an epicyclic form of gear train, which is constructed as a unit separate from the remainder of the gear box and is engaged not by the switch controlled electro-magnetic clutches of the forward gears but by mechanical means. The normal form of this reverse gear consists of a sun gear wheel comprising the driving member, a number of planet gears supported on a planet carrier and an internally toothed annulus gear comprising the driven member. The planet carrier member is formed with teeth on its outer periphery. In the neutral position these teeth are free and no drive is transmitted. For forward drive the planet carrier is moved endwise so that the teeth on its outer periphery engage with the corresponding internal teeth of the annulus and the gear rotates as a unit, the speeds of driving and driven members being equal. For reverse drive, the planet carrier is moved endwise in the opposite direction until the teeth on its outer periphery engage with corresponding internal teeth on a fixed reaction member so that the annulus is driven in the opposite direction to the sun wheel and at a reduced speed as compared with the forward drive so that a reverse gear of approximately the same order of ratio as the first forward gear is obtained equivalent to the product of the reverse gear ratio itself and whatever gear in the forward drives, usually

either the third or direct gear in the gearbox proper. 60

Since therefore, movement of the reverse control lever to reverse position has no effect on the forward gear control switch it is easily possible for reverse gear to be employed in conjunction with the first or second gear in the gearbox proper, which would put excessive and conceivably destructive torques on certain parts of the transmission. 65

One object of the present invention is to provide means whereby simultaneous engagement of the reverse gear with a low gear in the gear box is prevented. 70

A further object of the present invention is to provide means whereby alternate forward and reverse movements can be obtained by movement of a single lever or other control only. 75

According to this invention, in a variable speed gear having multiple epicyclic gear trains wherein engagement of forward gears is obtained electro-magnetically and having an independent reverse gear train including driving and driven members and a planet carrier shiftable axially from a neutral or free position of the carrier to a reverse drive position, where the carrier is held against rotation, and to forward drive where it is coupled to and rotates the annulus, there is provided electro-magnetic means so arranged that on movement of a gear lever to obtain reverse, the said means is energised in order automatically to select a predetermined gear or direct gear in the forward gear train to give with reverse the desired overall gear ratio, mechanical means also being provided positively to shift the planet carrier into and out of reverse on operation of the gear lever. 80 85 90 95 100

The planet carrier is preferably shifted into and out of reverse by electro magnetic means which control the movement of the shift rod so that the effort required by the driver is cut down to a minimum or instead of electro magnetic means some form of hydraulic or other fluid actuated control is superimposed between the gear lever and the shift rod 105 actuating the planet carrier. Such an arrangement has an added advantage where the gear lever is remotely situated from the gear box. 110

In one way of carrying out the invention where a single gear lever is employed, the endwise movement of the planet carrier is effected by four solenoids.

- 5 Movement of the lever to any of the positions in the forward gears first energises the solenoid which moves the planet carrier of the forward and reverse gear to the forward drive position. Movement of 10 the lever to the reverse gear position first energises the other solenoid which moves the planet carrier to the reverse drive position and then energises the magnets for the third or fourth gear, whichever is required in conjunction with the reverse gear train to give the desired over-all reverse gear ratio.

In an alternative arrangement in which two levers are employed, that which controls the forward and reverse gear engagement (which can, in this case, be either electrical, hydraulic or mechanical) also acts as a master switch and cuts off the current supply to the normal gear control 25 switch lever when the lever is moved to put into operation the reverse gear, and in the neutral position also. The reverse position of this forward and reverse control lever is also arranged to energise the magnets for controlling either top or third 30 gear in the gearbox, whichever is required for obtaining the desired overall reverse ratio.

The invention is diagrammatically illustrated in the accompanying drawings as applied to a Cotal type four speed gear box in which figures 1 and 2 are layouts respectively of a single and two-lever electromagnetic control with the circuit diagrams 40 therefor.

Figure 3 is a sectional view on a larger scale, showing the forward and reverse epicyclic gear train with its independent casing and having a mechanical form of control.

Figure 4 is a sectional view of a hydraulic device for actuating the shift rod of the reverse gear.

Figure 5 is a layout of an electro-magnetically operating mechanism for shifting the forward and reverse planet carrier.

In the accompanying drawings, A and B (Figure 1 only) indicate gear selection levers, C the vehicle battery and G a Cotal type gear box on the casing D of which are four electrical connections corresponding to the electro-magnets which control the epicyclic gear trains therein, these 55 being represented at E<sub>1</sub>, E<sub>2</sub>, E<sub>3</sub>, E<sub>4</sub>.

For convenience of illustration a gate type gear change is shown in outline as indicated at H, the four gear positions being indicated at 1, 2, 3 and 4, bottom 60 or first gear being at 1, and so on.

Gear lever A as hereinafter described, on being moved to any one of its four (forward) gear positions causes the energisation of the appropriate solenoids E<sub>1</sub>, E<sub>2</sub>, E<sub>3</sub>, E<sub>4</sub>, for selection of the required 70 gear train as in any standard Cotal type box.

Lever A is also movable (see Fig. 2) in accordance with this invention to forward and reverse positions, respectively indicated by F, R; N being a neutral position in the gate.

In Figure 1, however, a second lever, the lever B is provided controlling the forward and reverse gears, the forward position also being indicated at F, reverse position at R and neutral at N.

Selection of the required gear ratio in forward drive is carried out by energising the solenoids E<sub>1</sub>, E<sub>2</sub>, E<sub>3</sub>, E<sub>4</sub>, as follows: 85 to obtain

1st gear, the circuits containing contacts corresponding to E<sub>3</sub>, E<sub>4</sub> are energised,

2nd gear, the circuits containing contacts corresponding to E<sub>2</sub>, E<sub>4</sub> are energised,

3rd gear, the circuits containing contacts corresponding to E<sub>1</sub>, E<sub>3</sub> are energised,

4th gear, usually direct gear, the circuits containing contacts corresponding to E<sub>1</sub>, E<sub>4</sub> are energised.

It will be observed that in each of the four positions of the gate there are two 100 electrical contacts wired up as shown to the solenoids E<sub>1</sub>, E<sub>2</sub>, E<sub>3</sub>, E<sub>4</sub>, thus movement of the gear change lever A to the bottom (1st) gear position will cause current to flow through the circuits to E<sub>2</sub>, E<sub>3</sub>. 105

Other forward gears may be selected accordingly.

Reverse drive is obtained by means of an independent epicyclic gear train, not shown in Figure 1 but illustrated in 110 Figure 8, which will now be described.

Referring first to Figure 3 of the drawings, 10 indicates a gear case, 11 being the input or driving shaft and 12 the output shaft. The epicyclic gear housed within 115 the casing 10 comprises a sun pinion 13 fast on the input shaft and an annulus 14 fast on the output shaft 12. A planet carrier 15 having planets 16 in constant mesh with teeth 17 on the annulus 14 is 120 rotatably supported by the shaft 11. On the periphery of the planet carrier 15 are teeth 18 adapted, when the former has been shifted to its forward drive position, to mesh with the teeth 17 on the inside of 125 the annulus 14. In its neutral position the planet carrier 15 is located in the position shown in the drawing where it is free to revolve, while in its reverse position it is shifted to the left to engage quadrant 130

teeth 19 fast on the casing.

It will be obvious that movement of the planet carrier to the right will bring its teeth into mesh with those on the annulus 5 and thereby lock the input and output shafts so giving a forward drive with a 1:1 ratio. On movement to the left the planet carrier will be held locked by the teeth thereon engaging the quadrant 19 10 with the result that the output shaft will be caused to rotate in the opposite sense to the input shaft 11 with a speed reduction corresponding to the ratio between the number of teeth on the sun 13 to those 15 on the annulus 14.

If the reverse gear were to be used in conjunction with the first or second gear in the gear box proper, the combined reduction would be such as to put excessive 20 torques on the transmission with consequent damage to certain parts.

To prevent this possibility, movement of the gear lever A to the reverse position R is arranged to energise a predetermined 25 gear, which may be third or fourth gear, and in the arrangement shown in Figure 2, it is third gear, being the gear required in conjunction with the reverse gear train in order to give the desired overall gear 30 ratio in reverse drive. For this purpose in the reverse position in the gate two contacts 20 are provided so that on movement of the shift lever A to the reverse position in the gate the circuits to the solenoids E<sub>1</sub>, 35 E<sub>3</sub> are energised, thereby causing third gear to be selected whenever in reverse.

When a single gear lever control is employed, it is preferred in order to minimise the physical effort to a minimum to effect the shifting of the planet carrier 40 from forward to reverse electro-magnetically by means of two additional solenoids with a third or fourth; if necessary, to control the neutral position of the carrier.

For this purpose there is provided a spring 45 loaded (reversing) contact 21 connected through circuit 22 to one of two solenoids 23, 24 (see Fig. 5) respectively controlling the movements of a shift rod 43 by means 50 of which the planet carrier is moved into and out of its reverse position. Solenoid 23 causes forward and reverse gear shift rod 43 (Fig. 3) controlling the movements of the planet carrier to shift to the left in 55 Fig. 5, which is in reverse direction. The other solenoid 24 shifts rod 43 to the right and is connected through circuit 25 to a spring loaded contact 26 which is operative over all forward gears 1, 2, 3, 4 to 60 complete their solenoid circuits and render them operative. Movement of the planet carrier to neutral positions between forward and reverse is controlled by a third solenoid 60, and if necessary a fourth 65 solenoid 61, the (neutral) contact for

which is indicated at 27; so that when the shift lever is in this position the solenoid 61 or 60 will remain energised.

Referring now to Figure 5, the gear selector rod 43 is shifted into and held in 70 forward and reverse positions by solenoids 24, 23, these solenoids operating through a common bar 53 having a pin 54 engaging one end of a double arm 56 on rod 43. The other half of the arm 56 is slotted as at 75 57 and in engagement with the slot is a pin 58 on a link bar 59 connecting the armatures of the two solenoids 60 and 61 for controlling the planet carrier in the 80 neutral position.

In the single gear lever operation the solenoids 23, 24 are respectively connected through circuits 22 and 25 with the reverse and forward contacts 21 and 25. (see Figure 2), while the neutral solenoids 60, 85 61 are electrically interconnected with neutral control contact 27 respectively through circuits 62, 63 to a spring loaded toggle switch 65 shown diagrammatically and having an arm 66 electrically connected through circuit 67 to contact 27. Arm 66 is limited in its movement by contacts 62<sup>1</sup>, 63 and is controlled by pegs 68 in an extension of the rod 43. In operation, to obtain any forward gear the 90 solenoid 24 is energised through 26 and draws the selector rod to the right. Switch 65 is then in the position shown in full lines in Figure 5, so that when neutral is next required, the current from 100 the neutral contact 27 will energise the solenoid 60. If reverse is required, solenoid 23 is energised and draws selector rod 43 to the left at the same time pushing over the toggle switch to 105 the left to the position shown in dotted lines to make circuit 63, so that when next neutral is required, the neutral contact 27 will be connected to solenoid 61.

In some cases it may be desirable to provide a 2-lever control with separate forward and reversing gear levers. In this arrangement forward and reversing is controlled by the reversing gear lever B, see 115 Figure 1, while all four forward are controlled by lever A. Lever B in its reverse position engages contacts 28, 29 having connections 30, 31 to the solenoids E<sub>1</sub>, E<sub>3</sub>, and with a third contact 32 with connection 33 to the reverse solenoid.

In its forward position, lever B in addition to contacting contact 34 connected through 35 to the forward operating solenoid of the carrier, completes a circuit 125 through contacts 36 and connections 37, 38 with independent contacts on the gear lever A. The lever B will therefore cut off the current supply to the normal gear control when it is moved out of the for- 130

ward position F into reverse or neutral positions, the neutral position being at N where contact is made with contact 27 of circuit 67.

5 It will be seen that this forward and reverse control lever functions as a master switch which enables any of the gears to be put into operation when it is in its "forward" position but, when moved to 10 its "reverse" position, only the third or fourth gear is energised.

While it is preferred to shift the shift rod 43 of the planet carrier by electro-magnetically operating means, it is not 15 essential and instead direct manual control between the lever B (see Figure 3) and the planet carrier may be used. In Figure 3 lever B is pivoted at 40 and has one arm 41 connected through link 42 to a selector 20 rod 43 which positively shifts the planet carrier through a selector fork 44 which operates in a peripheral groove 45 in the planet carrier. It will be understood that Figure 3 is diagrammatic and that the 25 lever B functions in exactly the same manner as lever B in Figure 1, corresponding contacts (not shown in Figure 3) being provided to ensure that the appropriate forward gear is selected when lever B is 30 moved to reverse.

In another arrangement, the planet carrier may be shifted by a fluid pressure or other hydraulic type device. Such an arrangement is shown in Figure 4, in 35 which the selector rod 43 is fast with a spring biased piston 46 having two springs 47 and 48, which tend to return it to the central or neutral position shown. Opposite sides of the piston are connected 40 by fluid pressure pipes 49, 50 to a slide valve 51 under the control of lever B. Otherwise the electrical control of the forward gear ratio to be used in conjunction with reverse functions as described in connection with Figure 1. It will be understood that in both the Figures 3 and 4 constructions, the counterparts of the contacts shown at 34, N and R are not required.

It will be understood that the expression 50 "gear lever" used throughout the specification and in the appended claims should be read to include "any known type of control member" and is not restricted to a lever actuated gear change control by 55 means of which the gear change can be effected.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to 60 be performed, we declare that what we claim is:—

1. In a variable speed gear having multiple epicyclic gear trains, the combination with electro-magnetically 65 actuated means for selecting any desired

forward gear ratio, of independent reverse gear including driving and driven members and a planet carrier shiftable axially from a neutral or free position of the carrier to a reverse drive position, where 70 the carrier is held against rotation and to forward drive where it is coupled to and rotates with the annulus, electro-magnetic means controlling a predetermined gear train or direct drive in the variable speed 75 gear capable with reverse of giving the desired overall reverse gear ratio and mechanical positively acting means for shifting the planet carrier into and out of reverse position and controlled by a 80 reversing lever and so arranged that on movement of the lever into reverse position, the electro magnetic means is energised to select the desired gear train for 85 reverse.

2. In variable speed gear having multiple epicyclic gear trains, the combination of a single gear lever control, electro-magnetically actuated means adapted on movement of the lever into a 90 determined forward position to select the corresponding forward gear, reversing gear including driving and driven members and a planet carrier shiftable axially from a neutral and free position to forward 95 and reverse drive positions, a shift rod for shifting the planet carrier into and out of reverse position, independent electro magnets one or other of which is energised on movement of the gear lever into forward 100 or reverse to actuate the shift rod to operate the reversing gear accordingly and so arranged that movement of the gear lever to reverse also energises the electro magnets controlling a predetermined gear 105 train or direct drive in the variable speed gear giving the desired overall reverse gear ratio.

3. Variable speed gear mechanism as claimed in Claims 1 or 2 comprising independent gear levers for reversing and forward in which the forward gear lever is capable of selecting any forward gear and the reverse gear lever controls forward and reverse and is so arranged that when in 110 neutral and/or reverse those forward gear circuits controlled by the forward gear lever are broken.

4. Variable speed gear mechanism as claimed in Claims 2 or 3 in which the 120 planet carrier shift rod is actuated by a hydraulic or other fluid pressure system in place of electro-magnetically operating means.

5. Variable speed gear as claimed in 125 Claim 4 in which a fluid pressure device is interposed between the selector fork mechanism and the gear shift lever, said device comprising a cylinder having a piston operable by fluid pressure and controlled 130

by a slide valve actuated by the shift lever.

6. Variable speed gear mechanism as claimed in Claim 2 comprising a single gear lever and so arranged that on movement to any of its forward positions and to reverse position, it first energises the solenoids which shift the planet carrier.

7. Variable speed gear as claimed in Claim 3, in which the forward and reverse gear lever operates as a master switch and breaks the circuit controlled by the gear selector lever when put in reverse and/or neutral.

8. Variable speed gear as claimed in the foregoing Claims 2 or 6 and solenoid control mechanism for the planet gear substantially as illustrated in Figure 5.

9. Variable speed gear substantially as described and illustrated in the accompanying drawings.

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Dated the 5th day of April, 1946.

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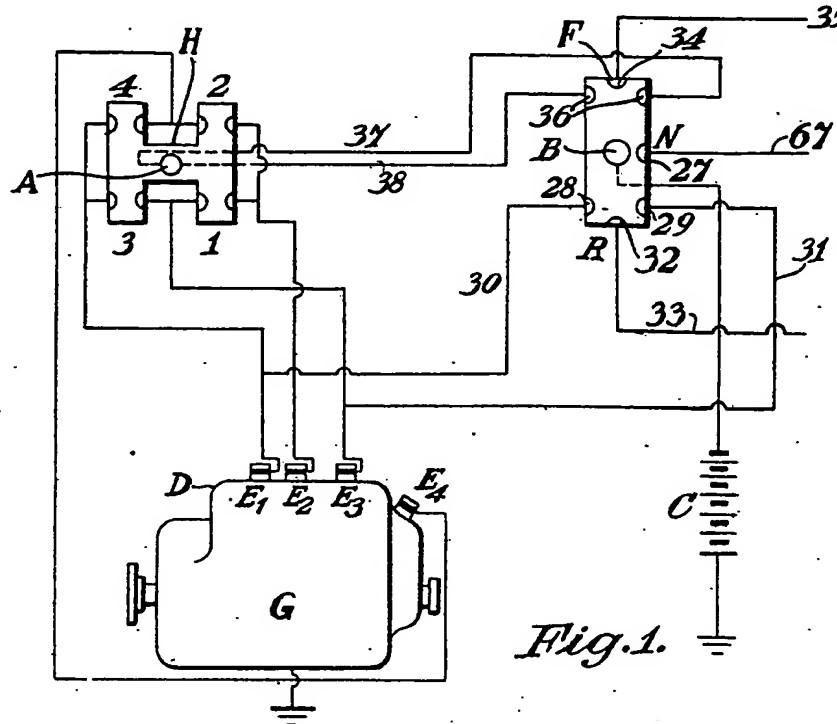


Fig. 1.

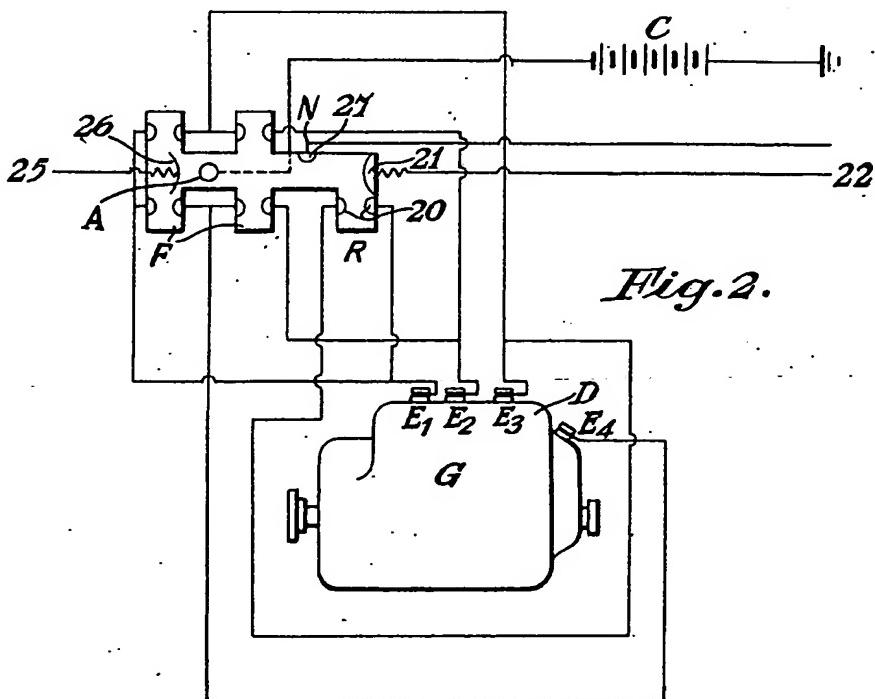
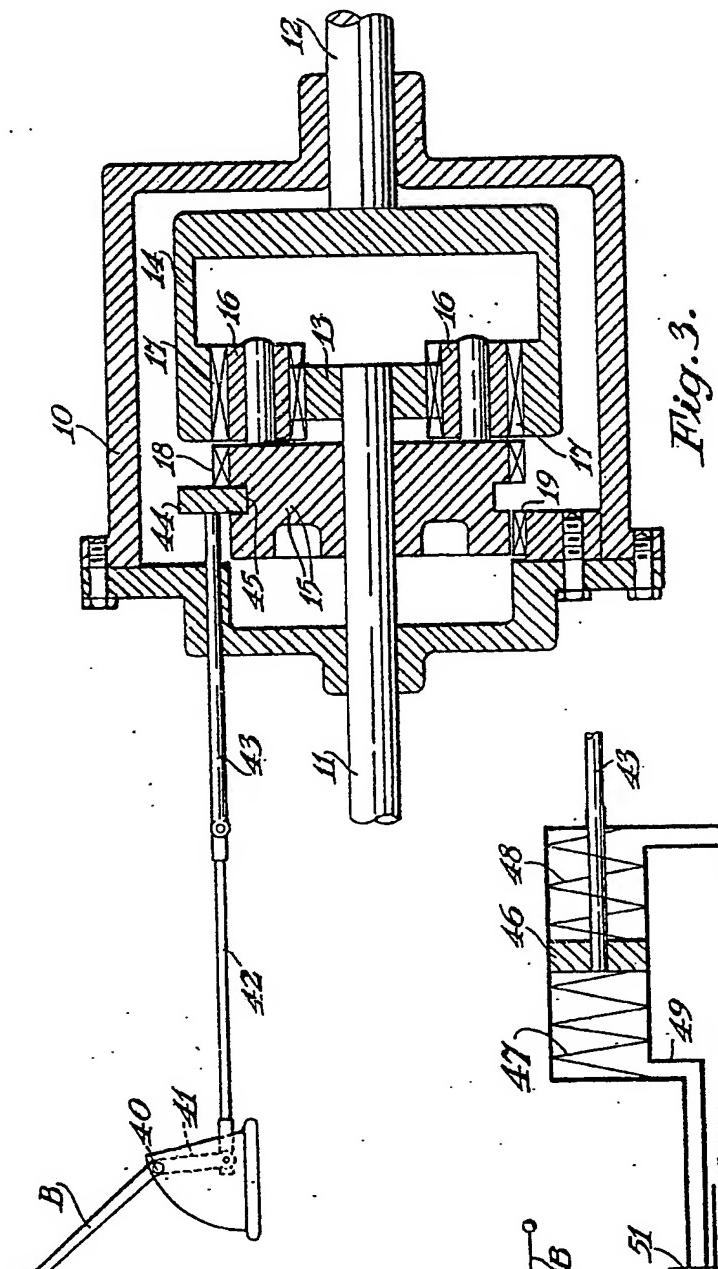
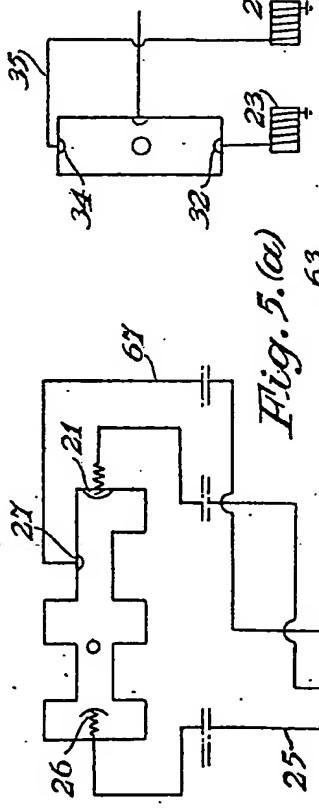


Fig. 2.

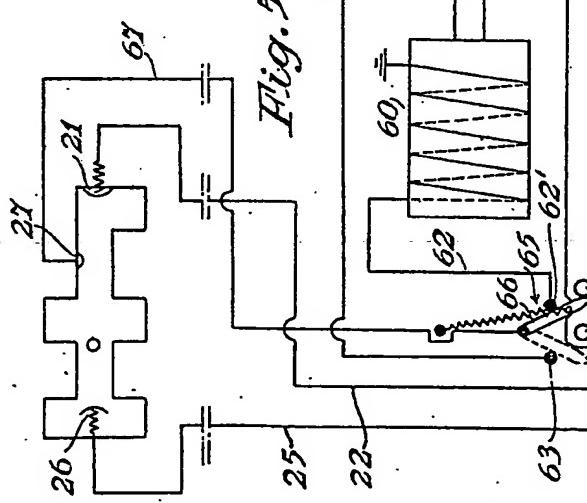
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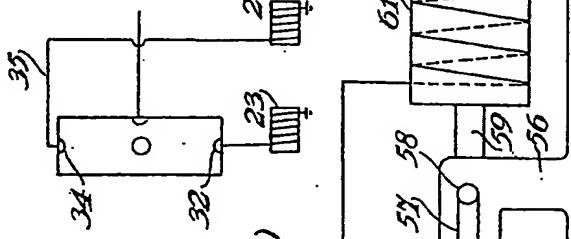
*Fig. 4.*



*Fig. 5(a).*

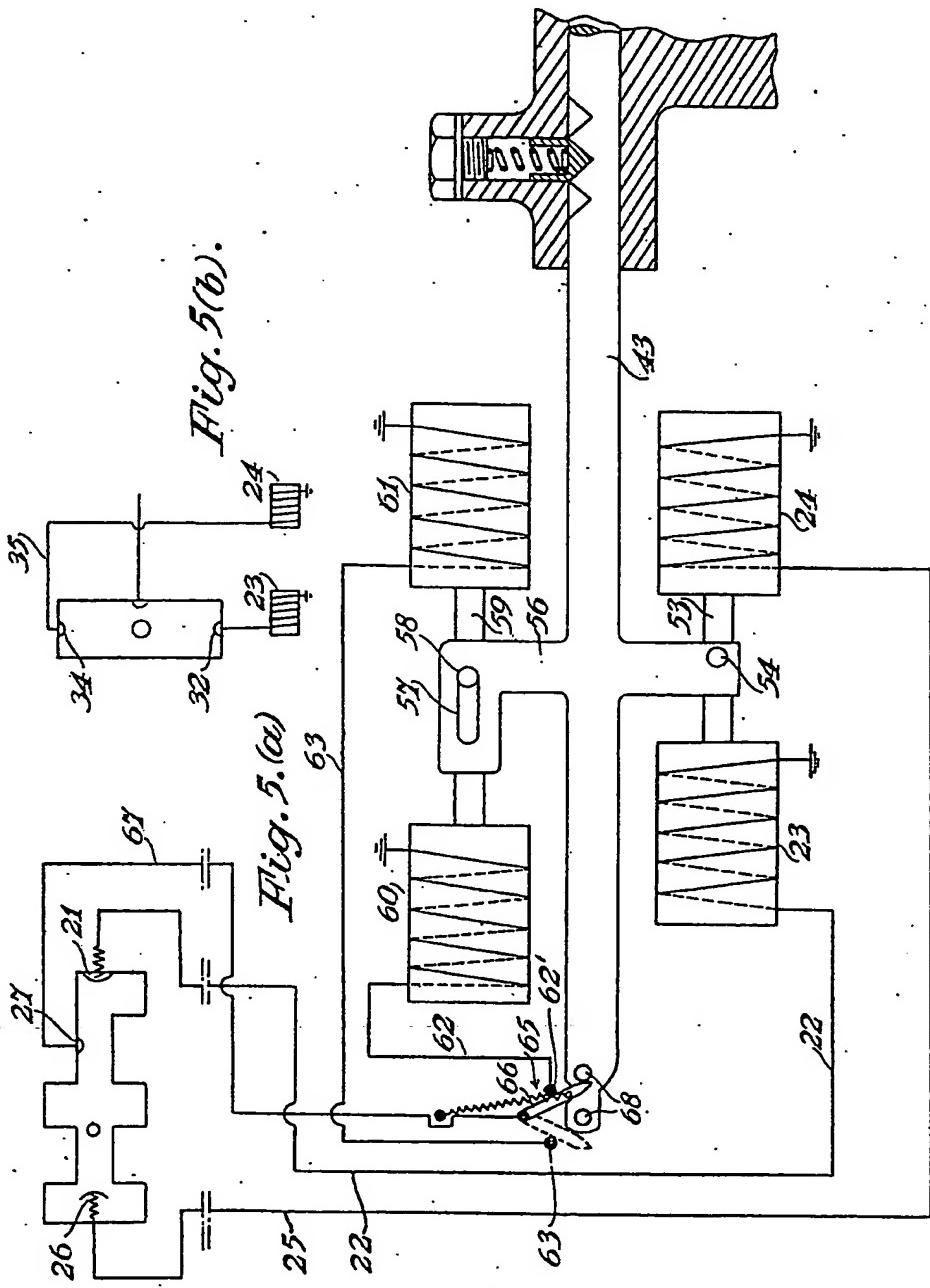


*Fig. 5(b).*



SHEET 2

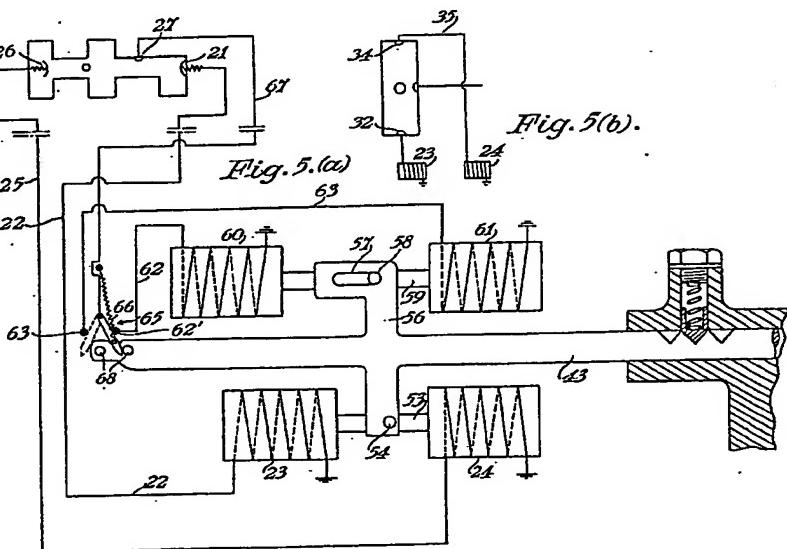
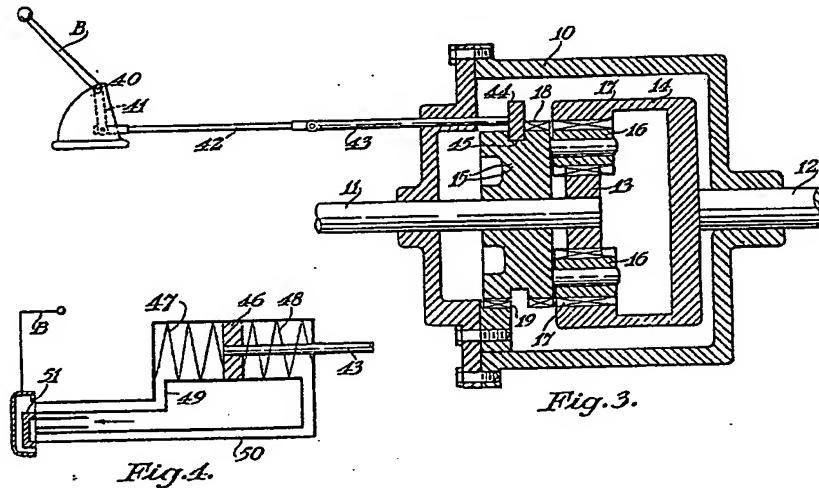
3 SHEETS  
SHEET 3



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591,153. COMPLETE SPECIFICATION

SHEET 2



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